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FACT SHEET

Douglas-fir Tussock Moth Situation

Pacific Northwest Region
Washington - Oregon

October 1972
(Revised November 8, 1972)

Forest Service
U.S. Department of Agriculture

Resume'

Outbreaks of the Douglas-fir tussock moth were formerly controlled by the aerial application of DDT, but all registered forest uses of DDT have been cancelled or suspended. The United States Forest Service, in a search for safer ways to control destructive forest insects, tested two promising insecticides against this moth during 1972 in Washington and Oregon. This series of field plots showed that one of the insecticides tested, Zectran, may give control when properly applied to early stages of the moth's larvae. Knowledge gained from these and future tests will be used to assist in the securing of a label registration providing for this use of Zectran and for developing future control strategies.

The Insect

The Douglas-fir tussock moth, (Hemerocampa pseudotsugata Mc Donnough) is an insect native to the forests of western North America. During its life, this insect passes through four stages: egg, larva, pupa and adult.

The adult male moth is an ordinary grayish-brown moth with feathered antennae and a wingspan of one inch or slightly larger. The female moth is very different in appearance, having tiny, underdeveloped wings which cannot be used for flying. She is almost all abdomen which is covered with grayish hairs except for the tip which is covered with a mass of long, dark hair.

Adult moths emerge from their cocoons from late July through early September. Since the female cannot fly, she clings to the outside of the cocoon and emits an odor which attracts the male moth. Mating takes place on the cocoon and the female deposits a mass of eggs, numbering up to 350 and averaging about 200 per mass. This egg mass is covered with a frothy, gelatinous substance containing many hairs from the moth's body.

The tussock moth overwinters in the egg stage and in late spring, after the host tree has begun new growth, the eggs hatch. Egg hatch extends over a period of several days depending on the micro-environment in which the individual egg mass is located. The egg masses may be located on the foliage, anywhere on the host tree, on underbrush, under or on top of rocks and logs on the ground, or even on the foliage of non-host trees.

The tiny, newly hatched larvae are fuzzy, long-haired caterpillars about 1/8-inch long. Their long hair and light weight allows them to be carried long distances by the wind. Since the female moth cannot fly, major dispersal of the population is by the wind-borne larvae. These young larvae crawl to the top or branch ends of the host trees and feed on the new foliage. The larvae grow slowly at first but during their five to seven moults, they grow progressively faster and eat proportionately more. After the new foliage has been consumed, the older foliage is fed on.

Mature larvae are up to 1-1/4 inches long and very colorful. Two long, dark tufts or pencils of hair similar to horns are located just back of the head; a similar but longer pencil of hair is on the opposite end. Four dense, buff-colored tussocks resembling a toothbrush are located forward along the middle of the back. The rest of the body, except the legs and head, is covered with short hairs radiating from red, button-like centers.

The body hairs of the larva are barbed and cause a skin rash on some people. These hairs are used to cover the cocoons and egg masses and serve to protect the moth from some predators.

The larva makes a thin cocoon of silken webbing mixed with body hairs to pupate in. There it transforms from the larva stage to an adult in a pupal or resting stage which extends from late July into August. The adult moths emerge from cocoons 10 to 18 days after entering pupation and the females immediately mate and lay eggs.

The Damage

The Douglas-fir tussock moth prefers to feed on Douglas-fir but subalpine fir, white fir, and grand fir are all equally acceptable. However, in any locality, after the caterpillars have eaten the preferred foliage, they feed on many other trees and shrubs. Larvae have been found feeding on ponderosa pine, western hemlock, and western larch after the preferred hosts have been defoliated. However, these species are usually not severely damaged. All feeding is done during the larval stage with the young caterpillars (larvae) eating the underside of new needles. Later, old needles are eaten or severed near their base and left entwined in silken webbing. Defoliated trees turn reddish-brown by July in most areas. Lower elevation stands are affected first. Tree tops are usually defoliated first and may be heavily webbed. Infested trees can be completely stripped by moths in one season and may die or produce a dead top. More commonly, mortality occurs after two or more years of successive feeding.

Severe epidemics have developed in the past in the Northwest. One of the first recorded lasted from 1927 to 1930 in northeastern Washington and destroyed more than 300 million board feet of Douglas-fir and grand fir. Another outbreak from 1946-1948 covered 500,000 acres in eastern Washington, eastern Oregon, and northern Idaho. Several smaller outbreaks in the last 10 years have occurred around Deer Park, Washington, and Coeur d'Alene, Idaho. An aerial survey in the summer of 1963 detected 40 to 50 farm woodlots in eastern Washington being defoliated by the moth with the infested areas varying in size from 1/4 to 25 acres. In 1965, the moth defoliated firs on 65,000 acres of the Malheur and Ochoco National Forests in Oregon.

Natural Control

The Douglas-fir tussock moth has many natural enemies, including insect parasites and predators, birds and disease organisms. One, if not the most important, is a nucleopolyhedrosis virus which causes a disease that is capable of wiping out high moth populations. This disease kills both larvae and pupae and is usually present in some degree within all populations but often does not control the moth until the trees have been seriously defoliated.

At the present time, considerable research effort is being made in an attempt to develop methods for using the virus disease as a biological control method. Although this approach appears promising, it will be several years before it is ready for field use.

Chemical Control

Many outbreaks of the Douglas-fir tussock moth have been controlled by the aerial application of DDT. The last time this method was used in Region 6 (Washington and Oregon) was in 1965 when 3/4 of a pound of DDT per acre was applied by helicopter to 65,000 acres of the Malheur and Ochoco National Forests in Oregon. Although DDT is the only known, proven and efficient method of controlling the tussock moth, it has fallen into disfavor because of its persistent qualities and the possibility of endangering the food chain in areas where it is used. A substitute pesticide less persistent and more specific to the target insect is required.

Although a biological control method is preferable, chemical methods are needed to supplement them in most cases. Biological control methods are too slow or ineffective in many situations, particularly in the early phases of a population buildup.

Forest Service scientists have spent many years testing a large number of promising insecticides for the suppression of forest insects. This effort produced two promising candidates for control of the Douglas-fir tussock moth. A stabilized formulation of pyrethrins, the oldest pesticide known to man, and Zectran, a recently developed short-life carbamate are the most promising to date.

Pyrethrins - A group of several insecticidally active materials found in the daisy-like flowers of pyrethrum, a member of the chrysanthemum family. These ground-up flowers were used in Persia as an insecticide nearly 2,000 years ago.

The natural pyrethrins are very unstable and break down rapidly in sunlight. While desirable for use in the home, this rapid breakdown proved to be a severe drawback in forest spraying. A "sun screen" was developed

by combining an antioxidant and an ultraviolet screening agent in a mineral oil formulation, a combination for which a Government patent was issued in 1971. This "sun screen" allows the insecticide to remain active for at least four hours--long enough, it was hoped, for it to be effective.

Pyrethrins are nontoxic to humans and other warm-blooded animals which is very desirable, especially when it is considered that aerially-applied insecticide materials may come in contact with the whole forest environment. Because these compounds are nonpersistent, they will not remain in the environment nor build up in the food chain. After 4 hours, the pyrethrins are essentially gone but during this period, in laboratory tests, they proved to be 13 times as toxic to the tussock moth as DDT.

Pyrethrins are listed in the Washington State University Chemical Insect Control Handbook as not hazardous at any time to honey bees. No precautions would need to be taken if hives were present in areas to be sprayed with the pyrethrins.

The Farm Chemicals Handbook for 1972 states that pyrethrins have a low order of toxicity to warm-blooded animals, are not hazardous to apply and produce no harmful residues on food crops. Because of its safety, pyrethrum extracts are used extensively in stock sprays, pet sprays, household sprays, and to protect stored food in warehouses.

Zectran - A recently developed organic carbamate compound which has been highly effective in tests against the spruce budworm, another destructive forest pest. Laboratory tests conducted by the Insecticide Evaluation Unit show Zectran to be twice as toxic to the tussock moth as DDT.

In extensive field tests conducted from 1964 to 1969 against the spruce budworm, Zectran proved safe for handlers using it under field conditions. Although it has a relatively high oral toxicity to mammals, it has a much lower dermal and chronic feeding toxicity which is the main potential hazard in field use.

Studies by the Bureau of Sport Fisheries and Wildlife Service at Denver, indicated that Zectran had no cumulative effect. Daily doses of Zectran producing symptoms of toxicity could be tolerated by mule deer for several months without any permanent detrimental effects. Zectran is especially safe to fish. It is one of the least toxic chemicals tested on game fish by the Bureau's Fish Pesticide Laboratory at Denver.

Zectran is a nonpersistent insecticide, breaking down in sunlight and air within a few hours. Like most insecticides which are nonpersistent, Zectran breaks down into other compounds. These breakdown products have been studied, both in the field and in the laboratory, to determine if they were toxic or persistent and it was found that they were rapidly degraded to nontoxic materials.

Zectran and DDT were compared by spraying Douglas-fir trees at rates equivalent to those used in forest spraying. Sprayed foliage was aged and then tested on caged insects. The residual life of Zectran was very short, almost no toxicity after two days while the toxicity of the DDT-treated foliage was essentially unchanged during this time.

Zectran is listed in the Washington State University Chemical Insect Control Handbook as hazardous to honey bees. All hives in areas to be sprayed should be removed during the period of spray application.

During the period 1965-1968, the Bionetics Research Laboratories, under contract to the National Cancer Institute, tested various pesticides and related compounds for possible teratogenic (abnormal growth) effects. Zectran is one of a number of compounds tested by injecting the insecticide beneath the skin of mice. Zectran produced no significant increase of abnormalities in the two strains of mice tested.

Research work by Ishii and others concluded that Zectran, applied at the rate used in the current field test, is 117 times less than the amount required for a 90 percent chance of killing a 100-pound deer feeding exclusively on treated material in the spray area.

The effects of Zectran on fish have been studied intensively both in the laboratory and in the field. During the 1965 Zectran tests against spruce budworm, the Bureau of Sport Fisheries and Wildlife undertook a study of the effects of Zectran on trout and aquatic organisms. No direct effect of Zectran was observed on live-caged trout. Fish reacted normally throughout the test. There was an increased drift of dead insects in the stream at all sampling stations immediately after spraying. However, this resulted in only a temporary decrease in the aquatic insect population.

Additional studies of the effect of Zectran on aquatic insects conducted in Maine during 1967 showed no significant change in insect numbers in either bottom samples or drift samples following treatment. Zectran also had no observed effects on live-caged eastern brook trout nor were any dead fish observed in blocking nets placed across the streams at time of spraying.

The Current Outbreaks

1971

Populations of the Douglas-fir tussock moth developed to epidemic proportions in several areas of central Washington. The largest area and heaviest defoliation occurred in 1,500 acres of timber just above the orchards along Highway 2 between Cashmere and Leavenworth. This population collapsed during August and few overwintering egg masses could be found in the fall of 1971.

Approximately 2,000 acres of Douglas-fir were defoliated to some degree on the northwest slope of Mt. Hull, three miles southeast of Oroville. This outbreak is referred to as the Oroville outbreak in this report. Most of the timber infested is on Federal land and an overwintering egg mass to old egg mass survey revealed 20 new to each old, indicating a considerable population increase in 1972.

A third area of 800 acres was located 7 miles northwest of Riverside in the Pine Creek area. New egg masses were abundant in this area and a survey indicated a ratio of 32 new egg masses for each old and a moth population explosion was expected in 1972. This area is referred to in this report as the Riverside outbreak.

Forced hatching of moth eggs collected in October 1971, at the Oroville infestation resulted in seven virus deaths in a total of 1,660 larvae hatched or only a 0.4 percent virus incidence in the total sample. At the Riverside outbreak, 579 eggs were hatched and the virus prevalence varied from 0.32 percent to 2.95 percent with the heaviest virus incidence on the eastern side of the area. Doctor C. G. Thompson of the Pacific Northwest Forest and Range Experiment Station considered that these percentages were extremely low for the Oroville area and low for Riverside with neither high enough to contribute much towards control during the 1972 feeding period.

Several other small areas of infested trees were reported in the Lake Chelan and Entiat River areas of Chelan County. The damage potential in these areas was not evalutated prior to the summer of 1972.

In Oregon, subepidemic tussock moth populations were detected on the annual defoliator survey plots on the Umatilla, Wallowa-Whitman, and Winema National Forests. Foliage examinations made during the fall of 1971 on the Winema National Forest found few overwintering egg masses, indicating a collapsing or static moth population. No evaluation was made of the light moth populations present in the northeastern Oregon area.

1972

During the summer of 1972, no tussock moth activity was observed in the Cashmere-Leavenworth area but nearly complete tree mortality occurred in the area of heavy defoliation of 1971. Most of the moth-killed timber in this area was salvaged during the spring of 1972.

The Oroville infestation increased in size and intensity and severe defoliation was in progress during the period that insecticide field tests were being carried on. Later in the summer, there were indications that the virus disease was appearing in the late larval stages.

Moth populations in the insecticide field test areas at Riverside expanded and considerable defoliation occurred prior to the application of the insecticide. This infestation also spread over a large area to the south of the original outbreak. During late July, large numbers of dead larvae were also observed in this area and the virus was suspected.

During June and July of 1972, heavy defoliation by the moth occurred to the fir stands high on the hills on the west side of the valley between Oroville and Tonasket in an area where aerial surveys were unable to detect any feeding during 1971. When this area was examined in late July to evaluate the larval population for use in insecticide tests, it was found that a large percentage of the larvae were dead or dying. The virus disease was verified as heavy in all three areas and plans were changed to move remaining insecticide tests to eastern Oregon.

During June of 1972, collections from the annual defoliator survey plots indicated that the tussock moth population in northeastern Oregon was rapidly expanding, both in area and population density. When the aerial insect and disease detection surveys were made in this area in July, tussock moth defoliation was visible in parts of 33 townships in Oregon and 10 in southeastern Washington. A helicopter was used to more accurately map the infested areas and to record the degree of defoliation that occurred. Salvage timber sales in the most severely damaged commercial forest land areas are currently being prepared. Other areas will be salvage logged where necessary and feasible.

Aerial and ground insect detection surveys made during 1972 in other areas of Washington indicate tussock moth defoliation in areas south of Lake Wenatchee, on the Leavenworth watershed along Icicle Creek, on the south shore of Lake Chelan, and in several areas on the Colville Indian Reservation. Evaluations of these outbreaks are now being made.

An entomological evaluation of this outbreak is currently underway. This was delayed until late September when egg laying by the adult moths was completed. Data on the number of egg masses per tree, size of egg masses, ratio of new to old egg masses, and virus incidence in larvae reared from new eggs will be analysed in order to determine population trend and potential.

1972 Insecticide Tests

A cooperative effort to evaluate two insecticides when applied against the larval stage of the tussock moth was made during June and July. Cooperating in this effort were Region 6 and the Pacific Northwest and

Pacific Southwest Forest and Range Experiment Stations of the U. S. Forest Service, Oregon Department of Forestry and the Washington State Department of Natural Resources.

At Oroville, Washington, 0.05 pounds of stabilized pyrethrins per acre was applied by helicopter to 345 acres of infested Douglas-fir when the moth larvae were in the second and third instar. After spraying, the counts of dead larvae were high in drop boxes placed under the trees but population checks of the larvae made 1 day prior and 3 days after spraying showed approximately 45 percent of the original population still alive. A second application of the same insecticide at the same dosage rate was made 7 days after the original spraying. Once again large numbers of dead larvae fell out of the trees but the population counts made 3 days later revealed that about 25 percent of the original prespray population was still active. Surveys made in a check area 1 mile away showed a population reduction during this same period of 44 percent from natural causes.

Four-hundred acres of the tussock moth-infested area at Riverside was sprayed with 0.15 pounds of Zectran per acre by helicopter while most moth larvae were in the second and third instar. Population surveys before and 3 days after spraying showed better than 80 percent mortality on three of the four plots sampled. In the check area, natural mortality was 41 percent during the same period.

In mid-July the results of the Zectran spraying at Riverside looked promising enough that a decision was made to conduct additional tests with this insecticide against later (older) larval instars of the moth. The rapidly expanding outbreak in the La Grande area of northeastern Oregon was selected because of the large moth populations and the lack of evidence of any virus activity.

Starting on July 22, and finishing on July 25, three areas totaling 1,550 acres of mixed true fir and Douglas-fir were sprayed with Zectran. Two of the areas received 0.15 pounds of Zectran per acre while the other was given twice this amount, or 0.3 pounds per acre. Many dead and dying larvae were seen on the ground and falling from the trees after spraying but rather high numbers of larvae were still observed feeding on the foliage. At the time the insecticide was applied, most of the larvae were full grown fifth or sixth instar and, at the lower elevations, had pupated.

During these tests, the Zectran was applied at the given rate mixed in 1 gallon of fuel oil per acre, while the pyrethrins were mixed in 1/2 gallon of mineral oil per acre. In addition, tracer materials in small quantities were added to the sprays to aid in determining the coverage secured. All spraying was by helicopter at 50 feet above tree tops at 35 miles per hour.

Data from these tests are being analyzed and although results are encouraging, neither material can be recommended for operational use in 1973. The next step in the evaluation of the effectiveness of Zectran depends on the final results of all 1972 tests. It is recommended that the use of Zectran be tested on a large-scale pilot study basis in 1973.

The problem of applying a short-life pesticide over large areas where insect egg hatch occurrence covers a much larger time span must also be resolved.

Control strategies and decisions are dependent on the results of the biological evaluation currently being made. If it appears necessary, control plans utilizing all available proven techniques and methods will be made this winter in sufficient time to provide for wide-scale public review and scrutiny prior to the need for taking action on the ground.

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The following is a list of references which deal with the information in this fact sheet. The publications are recommended for further reading to anyone interested in the proposed test.

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DOUGLAS-FIR TUSSOCK MOTH INFESTED AREAS

	Acres mapped during aerial survey 1/			
	Trees killed	Top killing	Defoliated	Total
WASHINGTON				
Walla Walla Unit				
State and Private	0	1,080	3,270	4,350
Umatilla National Forest	1,740	10,810	38,050	50,600
Subtotal	1,740	11,890	41,320	54,950
Wenatchee Unit				
State and Private	0	440	2,040	2,480
Wenatchee National Forest	0	280	2,450	2,730
Subtotal	0	720	4,490	5,210
Colville Unit				
State and Private	1,680	870	440	2,990
Colville Indian Reservation	100	290	1,470	1,860
Subtotal	1,780	1,160	1,910	4,850
Omak Unit				
State and Private	2,930	2,500	6,320	11,750
Okanogan National Forest	280	0	1,120	1,400
Subtotal	3,210	2,500	7,440	13,150
Washington Unit Total				
State and Private	4,610	4,890	12,070	21,570
National Forests	2,020	11,090	41,620	54,730
Colville Indian Reservation	100	290	1,470	1,860
Washington total	6,730	16,270	55,160	78,160
OREGON				
La Grande Unit				
State and Private	3,750	13,820	20,140	37,710
Umatilla National Forest	5,090	33,470	37,030	75,590
Wallowa-Whitman National Forest	90	1,310	3,950	5,350
Oregon total	8,930	48,600	61,120	118,650
Grand total - Oregon and Washington	15,660	64,870	116,280	196,810

1/ Only areas where defoliation is visible from the air - does not include all areas where the insect has been found on the ground.

TOTAL INFESTED ACRES IN
LA GRANDE AND WALLA WALLA UNITS[1/]

	Defoliation Class			Total Infested
	Tree Kill	Top Kill	Defoliation	
	Acres			
Total Umatilla National Forest	6,830	44,280	75,080	126,190
Total Wallowa-Whitman National Forest	90	1,310	3,950	5,350
Total State and Private	3,750	14,900	23,410	42,060
Total acres infested	10,670	60,490	102,440	173,600

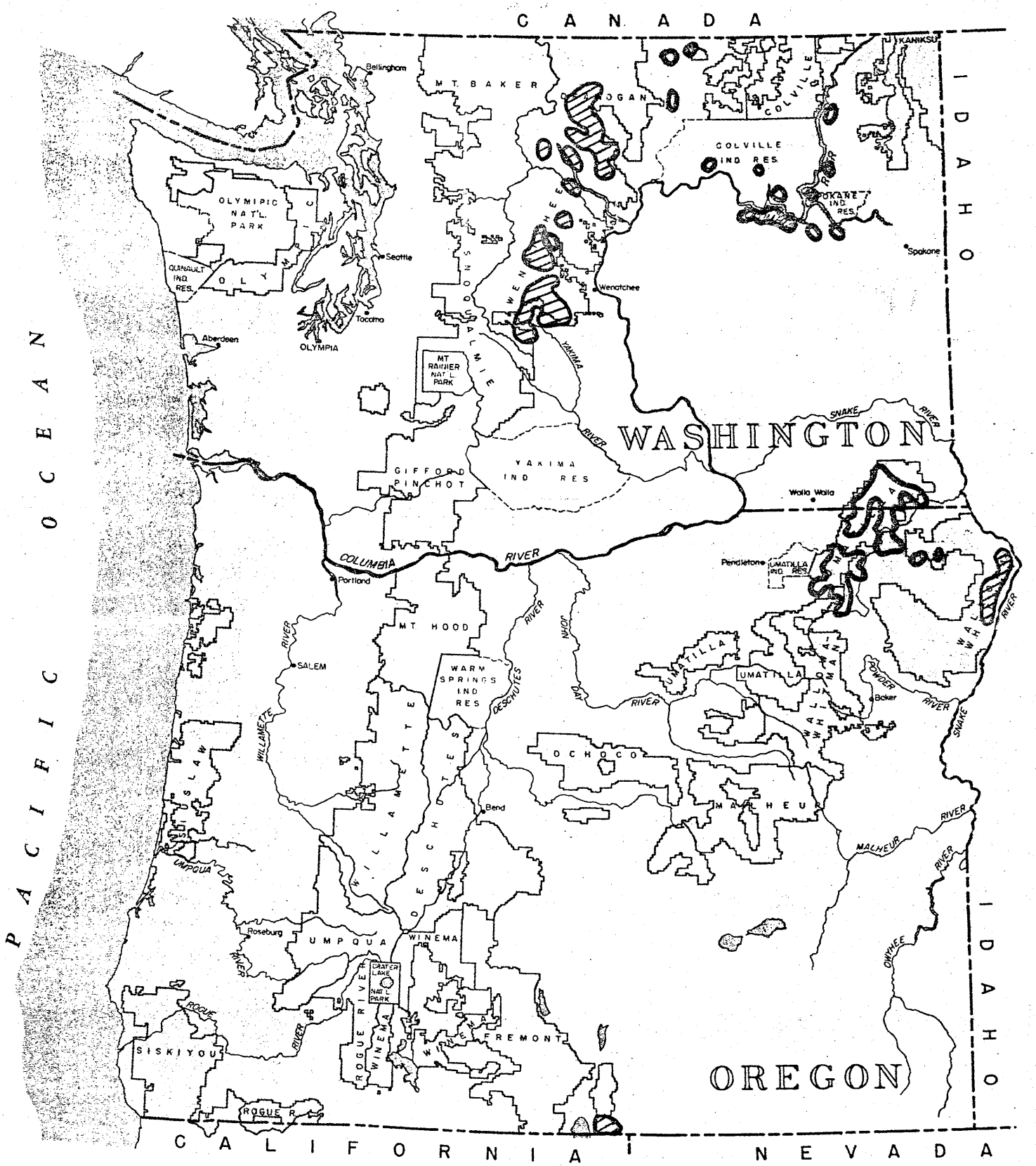
[1/] Only areas where defoliation is visible from the air - does not include areas where the insect has been found on the ground.

SUMMARY OF DOUGLAS-FIR TUSSOCK MOTH
INFESTATIONS IN ROADED AREAS

Unit	Defoliation Class: Tree kill	Top kill	Defoliation	Total infested
	Acres			
WASHINGTON				
Walla Walla Unit				
State and Private	0	1,080	3,270	4,350
Umatilla National Forest	380	3,090	13,380	16,850
Subtotal	380	4,170	16,650	21,200
Wenatchee Unit				
State and Private	1,680	1,310	2,480	5,470
Wenatchee National Forest	0	280	1,850	2,130
Colville Indian Res.	100	290	1,470	1,860
Subtotal	1,780	1,880	5,800	9,460
Omak Unit				
State and Private	2,930	2,500	6,320	11,750
Okanogan National Forest	280	0	1,120	1,400
Subtotal	3,210	2,500	7,440	13,150
OREGON				
La Grande Unit				
State and Private	3,750	13,820	20,140	37,710
Umatilla National Forest	4,890	27,580	24,150	56,620
Wallowa-Whitman National Forest	90	1,130	3,110	4,330
Subtotal	8,730	42,530	47,400	98,660
Total State and Private	8,360	18,710	32,210	59,280
Total National Forests	5,640	32,080	43,610	81,330
Total Indian Land	100	290	1,470	1,860
Grand total	14,100	51,080	77,290	142,470

SUMMARY OF DOUGLAS-FIR TUSSOCK MOTH INFESTATIONS IN UNDEVELOPED ROADLESS AREAS 5,000 ACRES AND LARGER

Unit No.	Name	Defoliation Class: Tree Kill	Defoliation Class: Top Kill	Defoliation Class: Defoliation	Total Acres Infested	Total Acres in Area	Percent Infested
		Acres					Percent
OREGON							
Umatilla N.F.							
8	Spangler	-	340	1,290	1,630	8,400	19
9	Upper Tucannon	-	1,570	5,920	7,490	28,700	26
10	Asotin Cr.	-	-	-	-	16,100	0
11	Hogback	-	-	-	-	5,000	0
12	Wenatchee Creek	-	-	360	360	15,700	2
13	Saddle Cr.	-	170	920	1,090	7,700	14
14	Moore Flat	240	260	1,800	2,300	8,900	26
15	Mill Creek Watershed	-	1,860	3,440	5,300	21,000	25
16	Timothy	-	440	1,760	2,200	20,500	11
17	Walla Walla River	200	1,910	3,810	5,920	22,600	26
18	Grand Ronde	-	-	20	20	6,100	<1
19	North Fork Umatilla Rvr.	-	790	1,200	1,990	19,900	10
20	Hellhole	-	1,390	4,070	5,460	60,200	9
21	Wenaha Backcountry	1,120	4,880	12,960	18,960	111,200	17
	Total	1,560	13,610	37,550	52,720	352,000	15
Wallowa-Whitman N.F.							
3	Tope Creek	-	-	-	-	7,000	0
4 & 4A	Joseph	-	-	280	280	28,300	1
13	Mt. Emily	-	180	560	740	11,000	7
	Total	0	180	840	1,020	46,300	2
WASHINGTON							
Wenatchee N.F.							
7	Nason Ridge	0	0	600	600	14,400	4
	Grand total	1,560	13,790	38,990	54,340	412,700	13



LEGEND

Forested Areas

National Forest Boundaries

Reservation and Park Boundaries

U.S. FOREST SERVICE
PORTLAND, OREGON

1972

Western Spruce Budworm Outbreaks

Douglas-fir Tussock Moth Outbreaks